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GENTES HERBARUM

Art. 1. Palmæ

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By L. H. BAILEY

1. Palms, and their Characteristics.

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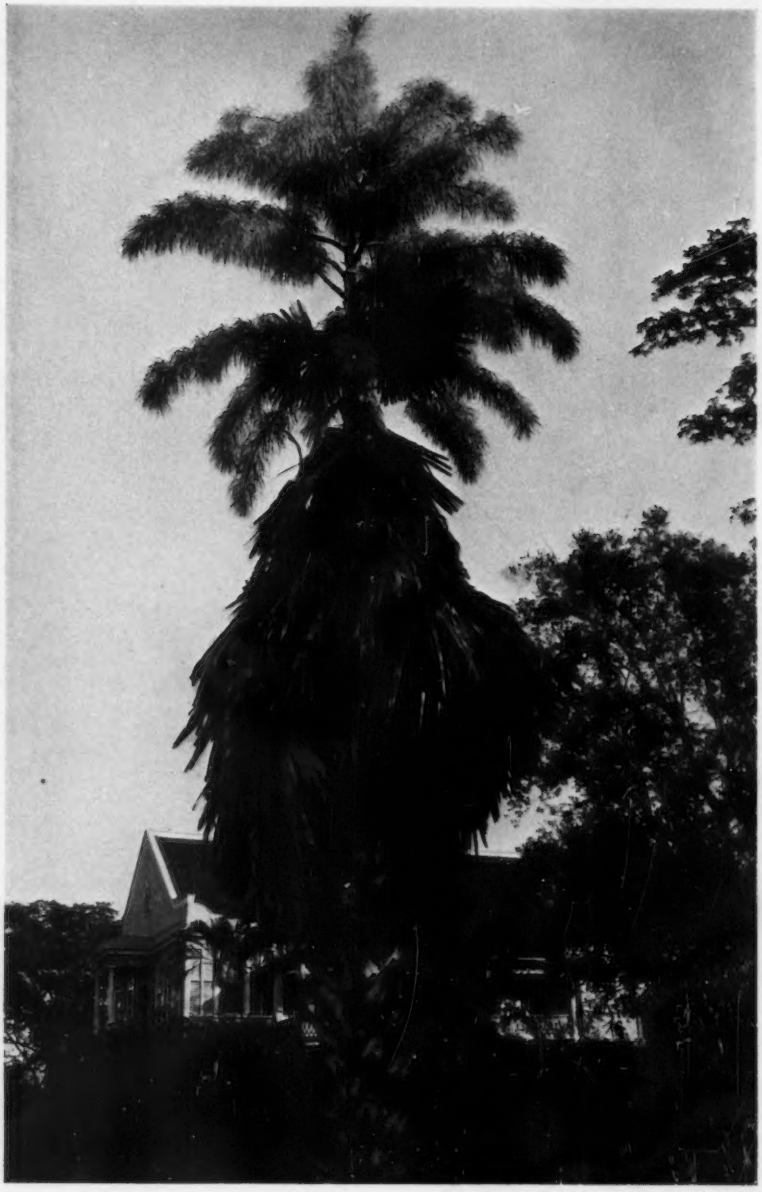

FIG. 1. GREAT FLOWER-CROWN OF TALIPOT PALM, *Corypha umbraculifera* of India; a tree 30 years from seed, on the island of Jamaica.

Exch.
The Author
3-23-1933

ARTICLE I.
PALMS, AND THEIR CHARACTERISTICS.

The traveler from cold countries is electrified when he lands on a tropical shore with palms abundant in the scene. The residents in regions of palms at once show them to visitors. Natives in tropical countries leave the big palms when clearing the forest. These plants provide the accent in many noted and historic landscapes. A single palm may make an otherwise tame scene to be a picture.

The palms have been associated with man from the earliest history and he has made uncounted uses of them; and he now employs them extensively in their juvenile state in cold countries for greenhouse work, in decorations in houses, churches, halls, hotels and stores and for these purposes they are grown in great quantities, in establishments representing heavy investment. The utility of palms is bound to take new directions and to increase, both as ornamental and interesting objects and as sources of important supplies. Yet we are singularly in need of more information about them, and this requires a few paragraphs of explanation.

The palms represent what is commonly considered to be the noblest family of plants; and yet they are to this day perhaps the least perfectly known, in general, of any of the great groups of vegetation. To be sure, a few kinds are familiar and persons are unaware that there are many others or that any special difficulty attaches to the identification of them. This complacency or indifference is itself one of the real hindrances in the situation.

Yet here is a family of plants that must be much better known in the interest of improved tropical agriculture, and of commerce in many useful commodities. Other palms than the date and coconut are capable of development as important fruit-trees; one need mention only the pejibaye or peach palm of the Costa Rica and Colombia region, a fruit that has been an important resource with aborigines and others for centuries. There is no reason to suppose that we have yet discovered all the important sources of palm oils or of vegetable ivory or fiber or wax or of other supplies for manufacture and the arts. It is not unlikely that the palms might afford us indices of soils, climates and other situations that are yet insufficiently studied.

The deficiency lies both in the fact that some of the important native palm regions have not yet been carefully explored and in the inherent difficulty of making clear identification of the different species. Many kinds that look very much alike in their young state or that may pass for

the same species show marked dissimilarities when they arrive at flower and fruit. There is also the physical labor of procuring adequate botanical material from tall palms in inaccessible places, and of preserving and transporting it. Foliage, flowers and fruits should be obtained from the same plant, and in many cases this means two or three visits to it.

Another hindrance to an understanding of the kinds of palms is the fact that many of them are of very local occurrence. The palms represent an old kind of vegetation, in a geological sense, and in such cases the species are likely to be isolated as stranded or vestigiary groups. With certain marked exceptions, the genera of palms are small, that is, of few species or kinds. In many cases the species in the genus do not exceed perhaps a dozen, and in other genera only one, two or three. Yet there are a few extensive genera. The rattan palms of India and beyond, of the genus Calamus, for example, are several hundred, and the species included in Bactris and in Geonoma in the western hemisphere also run to something like two hundred each.

Collections of growing palms are of course invaluable, although not sufficient for systematic study. There are several good gardens now in existence in the western hemisphere, but none of them is complete enough to form the basis of monographic studies of the palm family. There should be many more of them and also some kind of relationship between them all for exchange of material and information, for every kind of palm in the world should thrive somewhere in the Americas, each in the place best adapted to it. The Jardim Botanico at Rio de Janeiro lists somewhat more than 160 kinds of palms, and in one visit to it I obtained botanical material of more than 180 species. Other notable living collections are at Para, Georgetown in British Guiana, Canal Zone Introduction Gardens at Summit, Havana and Soledad in Cuba, Port-of-Spain on Trinidad, Castleton Gardens on Jamaica, at Roseau on the island of Dominica; and others might be mentioned. Of the hardier kinds there are several good collections in the United States of North America. Botanic gardens of palms provide evidence of adaptations to soils and conditions, and demonstrate the uses of the plants for parks, avenues and home grounds; and in themselves such gardens may be of great interest and beauty.

There is no one book in which, in recent time, the palms of the world have been brought together, and no current English treatise on them as a whole. There is no place to which one can go for full information on the palms of the western hemisphere. Only one attempt has been made by a resident on this hemisphere to publish a comprehensive illustrated treatise; this is the Sertum Palmarum Brasiliensium of the late illustrious Barbosa Rodrigues. This work is in two great volumes or parts, in portfolio form, and is now scarce and expensive. It covers only the palms of Brazil, some 427 in number of species and varieties, with many colored plates.

This is the work presented to Theodore Roosevelt when on his Brazilian expedition, "two magnificent volumes" contained "in a box of native cedar" (Through the Brazilian Wilderness, 109). It was made in Brussels, 1903, the narrative parts in French, the technical treatments in Latin. It is successor to Oscar Drude's monography of the palms of Brazil in Flora Brasiliensis, vol. iii, part 2, in 1882; and this work in turn is based on De Brasiliæ Palmis Singulatim, concluded in 1850, comprising vol. ii of Martius' monumental Historia Naturalis Palmarum. Yet, notwithstanding these noble publications and many other contributions, the palms of Brazil are yet imperfectly known.

Palms native in the southern United States are well in hand by Dr. John K. Small, who has published several interesting papers on them.

The economic possibilities

No one yet knows the economic potentialities of the palms or their proper place in tropical agriculture or their full meaning in forestry. We have noted in a preceding paragraph some of the commodities or resources that they yield. In the case of sugar alone the possibilities are astonishing. On this side the world we are so committed to cane and beets for the sugar supply that our minds are hardly open to suggestions of other sources. Yet it is stated (by Barrett) that about 1,000,000,000 pounds of palm sugar are produced each year, or "three-fourths of a pound per capita," which is an astonishing harvest. India has been consuming more than 400,000 tons of it annually. It has been said that, if properly tapped, the saccharine palms of the world "could produce more sugar than all the other sugar-yielding crops combined." Some dozen kinds of palms are well known as sugar-producers, and there are probably many other kinds in the western hemisphere. In most cases the palm is not injured by a careful sugar-tapping process, and many of the kinds are long lived. They are easy to grow in suitable soils and climates and the labor in manipulating them is not extensive. The sugar content of the sap may be as high as 16 or 17 per cent.

Sago or starch is a well-known product of many palms, most of these kinds also yielding sugar. A sago plantation is practically permanent and under good management the care-taking is not heavy.

Palm oil constitutes a major tropical crop, something like 200,000 tons of it being an annual production. The produce is a native African commodity but the plantations of the Dutch East Indies and Malaya are now yielding heavily. The African oil palm is considerably planted in the western hemisphere for ornament and general interest; and there are native occidental species that yield heavily of oil and on which careful investigations should be conducted.

An impressive commercial aspect of the palms is the growing of the plants for sale for ornament and planting. In the United States of North America palms are grown by the hundreds of thousands under lath and glass for the florist and plant trade; and in warm countries the sale of coconuts and young plants is an important industry.

The approach to the commercial possibilities of palms is, first, identification, as we have seen, and then the study of adaptations. Exploration is demanded, for discovery is by no means adequate or complete.

The landscape and ornamental value

The interest of the general observer and planter in the palms is as ornamental subjects. In this respect they are outstanding objects. They comprise trees, bushes and climbing vines. The foliage and habit are characteristic, and have become part of art, language and literature. The flowers are produced in great profusion, sometimes they are fragrant, and the fruits of many kinds are highly decorative. Little attention appears to have been given to soil reactions for the greater number of them, or to special difficulties outside the few present commercial or popular species. Nor is there any adequate standard body of knowledge and advice as to how palms may be employed in the landscape for best effect, at least not in North America.

Perhaps no major plants are employed with less discrimination in landscape planting. A palm is not valuable in a domain or a scene merely because it is a palm. It must fit its place and setting. Relatively few palms are adapted to avenues and not many street plantings, broadly speaking, are really successful. For artistic effect, they should be planted only where they thrive to their best, and where the leaves and flower-clusters do not need to be lopped to keep them within bounds. Of some kinds the "shag" or trunk-cover formed by the persisting old leaves is one of the most attractive characteristics, yet it is common practice to shear the bole and to leave the old scars and leaf-stubs, making unsightly objects; if the shag becomes foul and ragged and invites danger from fire, then these palms are not planted in the proper place. To choose the kind of palm exactly suited to any area or view requires experience and nice discrimination.

It is a cardinal principle in landscape planting that the plants should not be scattered promiscuously all over the premises. This principle holds equally whether the plants are maples, pines or palms; but the error is more evident with palms because they are so striking, and thus it comes that palm planting is likely to be unsatisfactory from the artistic point of view. Little or bush palms thrown over a place are particularly obnoxious, while they might produce a pleasing effect if massed about the margins or in certain areas. A single large palm in a commanding position may be worth more than twenty of them confusedly placed.

The shapes, textures, colors, flowering habits, are so various in palms that great choice is available to the planter. No doubt special landscape instructions need to be formulated for the guidance of those who live where palms may be utilized for the making of landscapes, with the merits of the many kinds carefully differentiated as to artistic values, much as such merits are being determined for deciduous plants in temperate climates.

The number of palms now in cultivation is surprisingly large, although the great variety available is not generally recognized. In the continental United States of North America, even though none of the territory is strictly tropical, more than 200 kinds in upwards of 90 genera have been recorded (Hortus, page 439), and most of them have been planted somewhere in the open ground. In the tropics the number is greater. This wealth of plant forms affords an excellent basis for study of artistic adaptations.

The foregoing paragraphs are assembled and adapted as part of an article I prepared on the request of the lamented William Allen Orton and published in Boletín de la Unión Panamericana, Julio, 1928, under the title "Las palmeras y su utilidad." This general statement may now be followed by more specific discussions on the study of palms.

On the Study of Palms

Although palms have been the subject of much writing and discussion for centuries yet are they still little known as a whole, except to special students. How many kinds are in the world is undetermined. In the author's shop an Index Palmarum has long been in preparation, entering all the genera, species and varieties. The Index now numbers about 7,000 cards. Of course many of the names are synonyms and duplicates. In a check-list or index of the palms of the western hemisphere prepared by B. E. Dahlgren and José Frambach of the Field Museum of Natural History in Chicago, soon to be published, about 1,100 tenable species appear. It can hardly be expected that half the palms of the earth are on this side of it.

There is now marked activity in describing new species of palms. For example, Dr. Max Burret of Berlin-Dahlem is active in this work, studying the great collections assembled there at the Botanischer Garten und Botanisches Museum. Excepting only Martius, he has described in the past few years more new species from the western hemisphere than any other author, approximating 300. He has also described many from the East. There is every probability that the inventory of either hemisphere is by no means complete.

Peculiar difficulties face the student of western tropical palms in the fact that there are no standard named herbarium collections in America,

FIG. 2. INTERFOLIAR FRUIT-BEARING OF COCONUT; island of Trinidad.

and very few records of type species. Therefore, the material must be newly compared with collections abroad.

The situation is further hindered by the circumstance that the literature of the western tropical palms is so widely scattered and that there are few recent monographs of genera. Not only is the literature in several languages but the portraits of plants, which speak a single language, are often inaccurate or even fantastic and in recent time new pictures have been made from the old ones. Photography should aid us here. It is difficult properly to represent proportions in large palm trees by means of drawings, and even photographs of very tall ones taken from the ground may be foreshortened. One must naturally always be critical of pictures of palm trees. Thus Richard Spruce, whose travels on the Amazon and Andes are well known, speaks of the notable book of Alfred Russell Wallace, Palm Trees of the Amazon, as follows: "The most striking fault of nearly all the figures of the larger species is that the stem is much too thick compared with the length of the fronds, and that the latter bear only half as many pinnæ as they ought to have" (Kew Journal, vii, 213, 1855).

To the inexperienced eye there are few kinds of palms. The differences seem somehow not to be noticed even when they are marked. This experience has been notable in the author's travels even with persons living in the tropics. Juvenile plants of widely dissimilar genera may be scarcely distinguishable except to the practiced eye. The reader will find interesting remarks on Wallace's experience in this respect in the preface of his book on the Amazon palms. It follows that critical study of palms should be based on flowering and fruiting plants of characteristic development, not on abnormal specimens grown outside the range and conditions in which they properly thrive.

If the species of palms are many, so are their forms astonishingly varied. Many of them are extensive hook-climbers, extending hundreds of feet. Others are little bushes, less than two feet tall at maturity. Some of them are ponderous, as Fig. 1. Still others are slender shafts rising nearly or quite 100 feet before a flower or leaf. Some of them are extensively forked or branched, Fig. 4; many are ferociously spiny. Certain species are monocarpous, dying top and root after once fruiting; examples are Caryotas, also the noble Corypha in Fig. 1. To this natural diversity is to be added the fact that to persons in general many kinds of plants are palms that bear no relationship to them.

We may further pursue the discussion of the study of palms by explaining somewhat the terminology in the description of them and then the assembling of material to represent them.

Fig. 3. Infrafoliar flower-bearing of a royal palm; Roystonea, introduced in Panama.

Terms

In the great natural families special terminologies have developed to express the particular organography of them. This is true, for example, in Compositæ, Gramineæ, Orchidaceæ, Umbelliferæ, Araceæ. Yet in the notable family of palms there is singular lack of such special terms, to aid the phytographer. Discussion of terms necessarily involves brief explanation of certain of the morphology, but this much at least the student must have to enable him to understand diagnoses.

The author has proposed a number of new terms to clarify descriptive work in palms, but they have not met with sufficient agreement among correspondents to make them useful now, and they are therefore mostly omitted in this paper and have not been published.

The flower system.

Flower-bearing in palms may be *suprafoliar* when terminal, borne above the leaf-crown as in Corypha, Fig. 1; *interfoliar* when amongst the foliage, visibly axillary to existing leaves, as in coconut, Fig. 2; *infrafoliar* when habitually issuing from the bole beneath the crown of leaves, well seen in the Roystoneas, Fig. 3.

FIG. 4. FORKING DOUM PALM OF AFRICA; Hyphæne, planted in British Guiana.

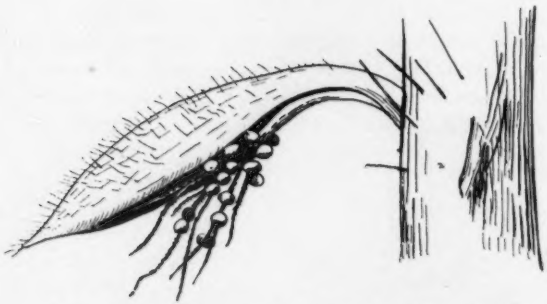

FIG. 5. DEFINITE SPATHE OF A BACTRID, with spadix underneath; *Bactris caryotæfolia* (× ½).

When flower-bearing is infrafoliar, there may be a definite flowering-point terminating the main or woody trunk and above that point another apparent smooth green bole; this part between the flower-clusters and the leaf-crown may be called the *crownshaft* (Latinized perhaps as *culmen superius*). It is well marked in Roystonea, Fig. 3; also in Œnocarpus and *Euterpe globosa*, as well as in Archontophœnix. This crownshaft is not a true trunk or caudex, but is composed of greatly expanded and lengthened erect leaf-bases inclosing the terminal bud or apex; yet it may be several feet long.

While the above examples are clear and habitual enough, there are many cases in which the cluster may appear either interfoliar or infrafoliar in the same species or even on the same plant, depending on whether the subtending leaf has fallen at the moment of anthesis. Some of the Chamædoreas are examples. These are really cases of interfoliar clusters. Morphologically, probably all clusters are axillary. This is the case even in the Roystoneas and Archontophœnices, but the leaves have fallen well in advance of anthesis and a crownshaft has developed above the flower-clusters. For descriptive purposes, however, the distinctions are useful. Similar Latin terms are employed in Bentham and Hooker, Genera Plantarum (and by others), as infrafoliaceous, interfoliaceous, terminal: *spadices infrafoliacei*, *spadices interfoliacei*, *spadices terminales*.

FIG. 6. WOODY UNOPENED SPATHE OF SCHEELEA, 9 feet long.

The flower-cluster of the palm is associated with one or more bracts, large or small. Sometimes a single bract constitutes a complete covering or inclosing shield of the bud, and which dehisces or ruptures to liberate the

cluster, much like a pericarp splitting to free the seeds; it may be only a few inches long and papery (Fig. 5), or several feet long and woody (Fig. 6) and in the latter case it may persist as a durable boat-like structure long after the flowers and even the fruits have fallen. In coconut the spathe remains as a single stave-like organ above the expanded flower-trusses (Fig. 7). In some cases the inclosing bracts are two or more, one of them frequently falling early. In other palms the bracts are only ligule-like sheaths associated with peduncles, and there may be separate bracts subtending the flower-branches. Fig. 8 is a young spike of tropical Sabal (shown in three lengths), not yet expanded, four feet long and bearing 36 sheaths or spathelets.

To all these bract-like and sheathing structures of whatever kind and morphology the word *spathe* is comprehensively applied in the literature, yet these parts are seldom spathes in the sense in which we understand the term in the aroids and similar plants, from which the flower-cluster emerges and which are foliaceous or corolloid and soon perish. The secondary and tertiary bracts are now called spathelets (spathellæ) or valves although the latter word should be reserved for the more or less equal parts of an inclosing sheath since valves (Latin valvæ) are the leaves or folds of a door.

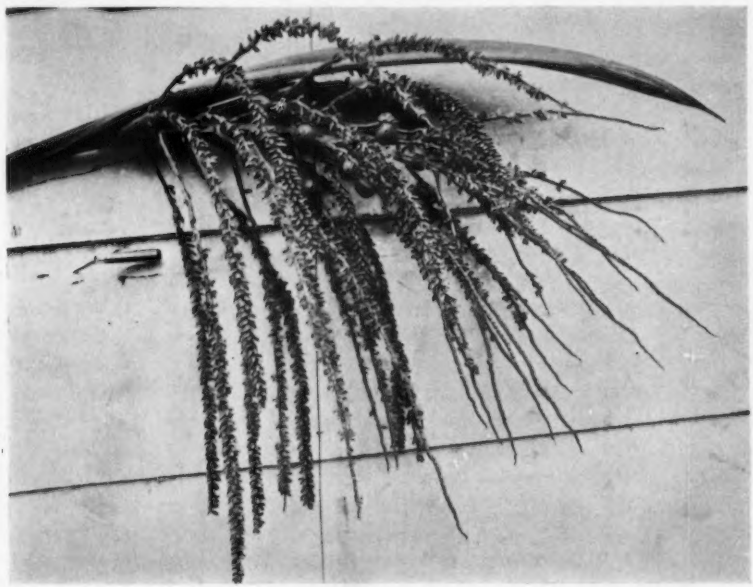

FIG. 7. INFLORESCENCE OF COCONUT, showing long narrow spathe above and spadix (flower-cluster) underneath.

FIG. 8. YOUNG FLOWER-SHOOT OF SABAL, showing spathes or bracts from the axils of which flower-trusses will issue; 4 feet long when the three parts are put together.

The word *spathe* was early applied to these structures on palms, even long before the days of accurate descriptive botany. These parts were also spoken of as involucres, skin, sheath, husk, covering, not to mention the "skinny sheath" of Parkinson. The palms known to the early writers, even to early post-Linnæan authors, were few and mostly of the kind that bear definite covering for the flower-cluster, as coconut and date. In great numbers of palms, however, these parts are so remotely or indefinitely associated with the developed flower-cluster as not to appeal to botanists as proper spathes, and one often has difficulty in maintaining the analogy and terminology.

In the early days of botanical description the word *spathe* was indefinitely employed for sheath-like structures, but usage has now applied it rather definitely to particular groups of plants; in the Englerian system the Series Spathifloræ comprises only Araceæ and Lemnaceæ. It is true that we still apply the term descriptively to the green and scarious bracts of Iris and some other plants, but it would be better if that practice were discontinued. That is, *spathe* should be re-defined and its use restricted to the Spathifloræ (Spadiciflores). In the palms, in particular, there might be a special descriptive term for these parts. In fact, investigation on the morphology of the palm envelopes may necessitate several terms to designate the parts.

The spathe is of untold variety and form and is characteristic of the genus and usually also of the species; yet it is seldom seen in herbarium collections. The literature abounds in inadequate and even erroneous descriptions of the spathe and spathelets of the different kinds of palms. There are no recognized technical terms to distinguish the different sizes, shapes and conformations.

If there is a spathe, so must there be a spadix; and the flower-cluster of palms is habitually so-called. This may be clear enough in the simple spike of certain Chamædoreas and Geonomas and bactrids (Fig. 5) in which there is a definite sheath in close association, but it becomes descriptively out of character when applied to such as cluster as in Fig. 7 and particularly to the enormous terminal flower-cluster of the talipot (Fig. 1) perhaps 20 feet high and as far across and branched into hundreds of parts, topping the great tree with a tower of bloom, if at the same time we apply the word to the flower-spike of Arisæma and Philodendron. When the organ is narrowed below into a long extension the part is sometimes called a *manubrium* or handle, becoming the peduncle of the spadix.

There is old usage to the effect that calyx and corolla do not exist in monocotyledons, and it has become the custom to speak of the parts of the perianth as segments, although *tepal* is an old term comparable with *petal* and *sepal* but without respect to an inner or an outer series. In many plants, of course, as in lilies, two whorls representing calyx and corolla are

not evident; in others, as trilliums, the series are marked. In palms the two series are often clearly distinguishable although the perianth is membranous or glumaceous and small. Many writers speak definitely of *sepals* and *petals* in palms, for descriptive purposes, and this practice is adopted in papers designed to follow this fascicle.

The floral envelopes are likely to persist and to enlarge in many of the palms, forming a dry durable fruiting perianth or cup, or "floral integument" of Martius, at the base of the fruit (Fig. 9); and this cupule is important in diagnosis.

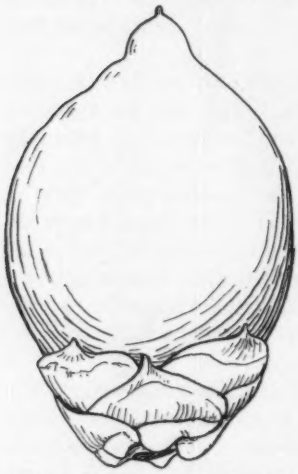

Fig. 9. Flower-cup or cupule of an Arecastrum, formed of the enlarged perianth parts; somewhat enlarged.

Leaves.

In the fan-leaved palms the petiole bears on the upper side at the junction with the blade an elevated or elongated projection commonly called the "ligule." It may or may not be morphologically comparable with ligules variously denominated in other plants. It provides an important mark of identification in palms, often as between species, but is not likely to be well shown in herbarium specimens. It may be called a *hastula* (Latin, *little spear*). Figs. 11, 12.

Fig. 10. The flower that produces the cup, in Fig. 9, closed just after anthesis (×1).

Fruits.

No good special terminology for the fruits of palms is available, and the descriptive terms common to other fruits and seeds are employed. The morphology of palm fruits is extensively various and it is not always easy or simple to make out the nature of the structures. As in other fruits, the *pericarp* comprises the layers inclosing the seed. The pericarp comprises the *epicarp*, the *mesocarp* which is mostly fibrous or fleshy, and *endocarp* which is the inside often bony layer or structure. If the fruit is drupe-like, the exterior succulent part is often called the *sarcocarp*. The *endosperm* or *albumen* is the starchy seed-content inside the *testa* or seed-coat. The albumen is *plane* or *ruminate* (Figs. 13, 14), in the latter case with irregular intrusions that sometimes become divisions. The hard nut or stone is the *putamen*, either the endocarp and seed grown together or hard shell alone. On the seed surface the *raphe* may show prominently and is often a diagnostic character.

In many palm fruits, as Manicaria, there are extra layers or coverings without distinctive name and the morphological origin of which needs careful study.

The flat appressed scales of certain palm fruits, as of Calamus and Raphia, have long ago been called *loricæ*, and may well be anglicized as *lorics* (Fig. 15). These loricate fruits present a definite phyllotaxy, the scales being in longitudinal series or *orthostichies*.

The ovary in palms is prevailingly 3-loculed, surmounted by 3 stigmas or stigmatic surfaces, a style rarely being present. Mostly one or two of the carpels or locules are aborted, and the fruit becomes 1- or 2-seeded. Usually, there are indications on the drupe or nut of the three divisions either in trigonous shape or in ridges; and in the coconut and related species the 3 carpels are recorded in the pores or "eyes" indicating the embryos even though two of the carpels may not develop. In a few cases all the carpels develop independently, the fruits then being 3. The seed usually exactly fills the cavity, explaining "semen loculo conforme" of the books. In a few anomalous palms there are aggregate carpels, forming a head of nuts; these, Phytelephas and Nipa, are sometimes separated in another family, Phytelephantaceæ, but such ordinal lines of separation are none too clear as evidenced by the intermediate Wettinia.

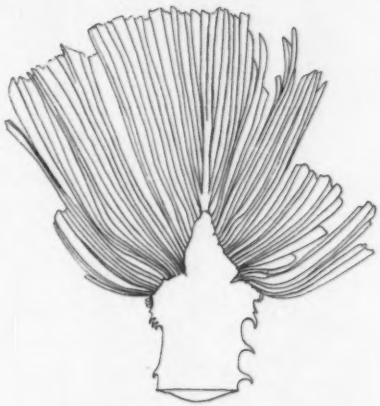

FIG. 11. SHORT HASTULA OF A WASHINGTONIA (×½).

The fruits of palms are remarkably diverse: stony and nut-like, spongy masses with seed inside, drupes, berries, dry and pod-like structures, glabrous, hairy, prickly, in size from that of a small pea to Lodoicea (double coconut) weighing 30-40 pounds with the largest seed in nature.

MATERIAL FOR THE PHYTOGRAPHIC STUDY OF PALMS

If one is to study palms one must have material that represents them. Usual herbarium specimens do not represent them; perhaps they may misrepresent.

It is a widespread opinion that palms cannot be studied by means of herbarium material but only from the living plants brought together in botanic gardens. This idea is notional. Palms lend themselves readily to

representation in herbaria. The foliage is easily preserved. The flowers hold shape and character even when dried much better than the soft or fleshy or irregular flowers of orchids, irises, figworts, aroids, and many others. It is necessary only to preserve the parts in such way as will constitute an adequate record. This requires definite planning, and also time and labor.

Living plantations in botanic gardens are of great interest and value, as already stated. It is a vast pity that a connected series of such gardens does not exist in the United States, not only as a basis of systematic study but as illustration to the people of some of the noblest forms of vegetation and which are far more adaptable in home and park planting even north of the Tropic of Cancer than we are aware. But botanic gardens alone cannot supply all the need in scientific systematic work, and five reasons may be mentioned. (1) The plants are not permanent; records of types, and illustration of the work of authoritative authors, must be as immutable as possible. (2) In no single place can anywhere near all the palms be grown to anything like perfection; some palms require torrid conditions, others extra-tropical; some are shade plants, others sun-loving; some thrive only in humid location, others in dry; some are soft-ground plants, others cling on rocks. (3) Modifications due to removal to unnatural conditions may be marked; workers in botanic gardens are well aware that many plants cannot be coaxed to do their best. (4) Not all the palms would come to flower and fruit at the same moment for comparison; and if they did, no person could carefully study any great number of them within a short

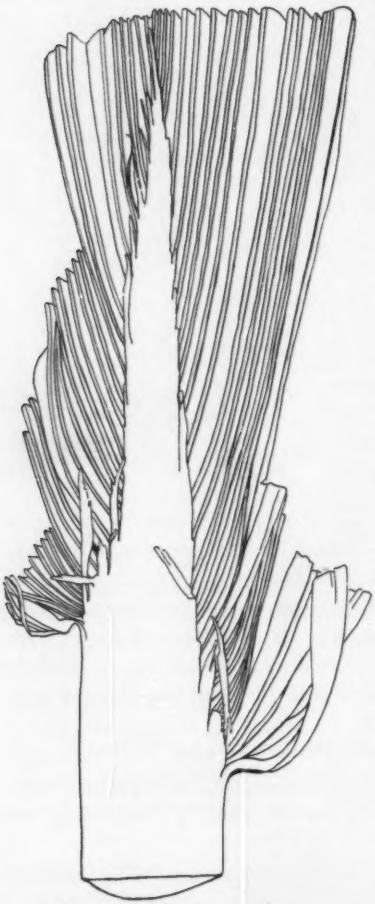

Fig. 12. Long hastula of a Washingtonia (× ½).

period; this means that specimens of the perishable or seasonal parts must be preserved: the larger the growing collection the more extensive should be the herbarium to represent and record the plants. (5) In any plants, adequate systematic study cannot be confined to the seasons in which they happen to be in field condition; such study must be unhurried; judgment must mature year by year; the student needs to go back over his work from time to time, to check his findings; fresh living material is of course desirable and often indispensable, but it is not sufficient. The most satisfactory study of palms, as of other plants, requires both field and herbarium experience. Moreover, the work must be undertaken in connection with a library, where standard references can be consulted and verified.

FIG. 13. RUMINATE ALBUMEN of *Euterpe globosa;* somewhat enlarged.

If one is to attempt a collection of palm material one must at the start abandon the prevailing concept of an herbarium. One would think that the object of an herbarium is to save space; but its purpose is adequately to represent the plants. Usually, persons visiting the author's modest palm collection remark that it requires too much space, to which he can only reply that this is not his fault. If the person does not wish to take the space or expend the effort, then there are other plants to which he may devote his attention. An herbarium collection of palms, as the writer conceives it, is not composed of specimens mounted on sheets, although the material may be contained in regulation herbarium cases.

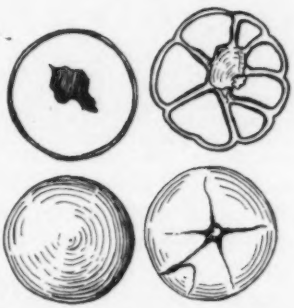

FIG. 14. DIVIDED OR RUMINATE ALBUMEN of COCCOTHRINAX, showing divisions even on exterior; left, plane albumen and exterior of Thrinax, cavity in center.

Although palm specimens may require much space, it is to be distinctly remembered that bulk or volume is of no importance,—it may be a hindrance. The different diagnostic elements should be assembled but no unnecessary material unless one is making merely a museum; whatever space is required to hold the requisite records should be willingly provided together with facilities for expansion.

The author has no intention of advising how palm specimens should be taken and prepared. He only describes briefly his own practice, the result of much trial and error in many places of both simple and difficult collect-

ing. This practice is with the intention of accumulating material for systematic study alone, within ordinary limited space and cost. The acquiring and setting up of museum and exhibition material is quite another effort, in which the writer has had no experience.

The size of the standard herbarium sheet is adopted. Fortunately the size in use in North America gives one considerable freedom. It is 11½ x 16½ inches. The author now uses only stout white-rag paper, and for some of the specimens an extra heavy grade. Sizes larger than the regular herbarium sheet cannot be shifted as need be in the cases of a general herbarium, and they are awkward to handle on ordinary tables.

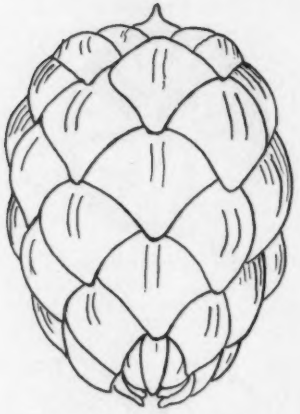

Fig. 15. Loricate fruit of a Metroxylon. (×1).

Certain specimens of small and soft palms may be mounted, but this practice is becoming constantly less in the author's practice. The specimens or pieces are folded to the size of an herbarium sheet, and are placed loose in specially folded sheets of regular mounting-paper quality but cut twice the usual size. If the sheet is 11½ x 24 inches it may be folded as shown in Fig. 16, and it goes into a regulation size genus-cover; but to hold bulky specimens, the genus-cover paper may be cut 25 inches long and so folded that it is one inch high (Fig. 16 underneath), making an "extension cover." If specimens are properly taken and prepared, leaf-parts may be removed from the covers and unfolded freely. On this basis all the foliage material is now collected for the author's herbarium. One soon learns how much of a palm leaf to take for an adequate representation of it.

The entire petiole is taken, even if several feet long, being cut into about 15-inch lengths; these pieces are kept in boxes and trays made for the purpose and that file in the pigeon-holes along with the other specimens. Petioles are sometimes 6 to 8 inches across and as hard as stove-wood; how much of such leaf-stalks should be taken will depend on the courage of the collector, but certainly sufficient to show what the member is like. How would one study oaks without leaf-forms and petioles?

Sometimes a half-dozen pieces of the leaf-blade are sufficient; often twice that number is needed. Pretty little fragments slit off the side of a leaf are about as useful as a tooth or two clipt from an elm leaf. In the large pinnate palms, leaves are 20 to 50 feet long. The great massive palmate species are even more difficult to manage for the leaves are sometimes almost metal-like in stiffness and rigidity. To procure material of

the great palms is like setting forth to collect a windmill except that one does not have the advantage of steps built on the derrick.

Specimens should be such as will show the nature of the pinnæ, if a pinnate leaf, from top to bottom (although not necessarily all the leaf), the alternation, mode of attachment, and unspoiled tips of the parts.

From a fan leaf (Fig. 17) one-half is discarded. The other half may be cut something like that shown in Fig. 18, and as many pieces as the col-

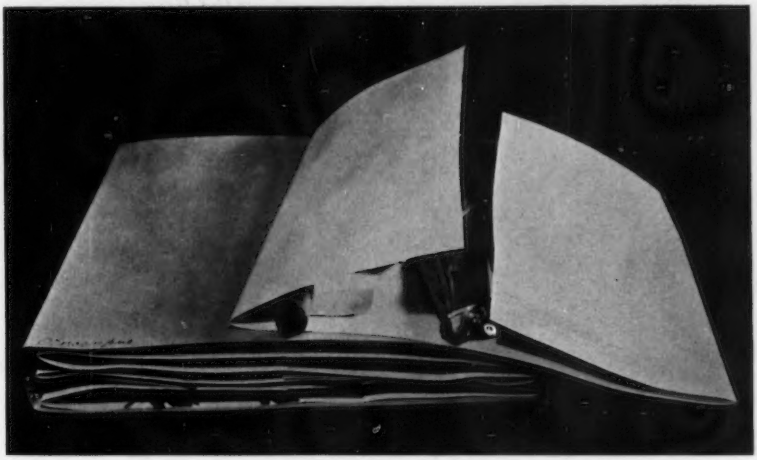

FIG. 16. FOLDED HERBARIUM SHEET (ABOVE), AND AN EXTENSION GENUS-COVER.

lector needs are folded, pressed and taken home. In the fan palm, the hastula or ligule (page 16) should always be preserved. Fig. 17 represents a medium-sized leaf. The petiole is 7 feet long, blade measures 8 feet by $5\frac{1}{2}$ feet. It readily conforms to herbarium requirements. It is a Corypha.

Of all small palms, sections of trunks 12 to 16 inches long should be taken, with armature and attachments intact, as in Bactris, Geonoma, Thrinax. Such trunks will be from one inch to three or four inches in diameter.

In many small palms the entire flower-cluster may be folded and pressed as also the sheaths (spathes and spathelets). But the flower-cluster may be 15 feet in length. Representative pieces, then, may be taken, the same as of the leaf. Be sure to collect both sexes; this means that one must know where the pistillate flowers are borne; some palms bear hermaphrodite flowers. The flowers will probably fall off in the drying process; they are then assembled in cloth or paper bags. The strands of the cluster must be kept even if naked, to show attachment and position of flowers as also pubescence and armature.

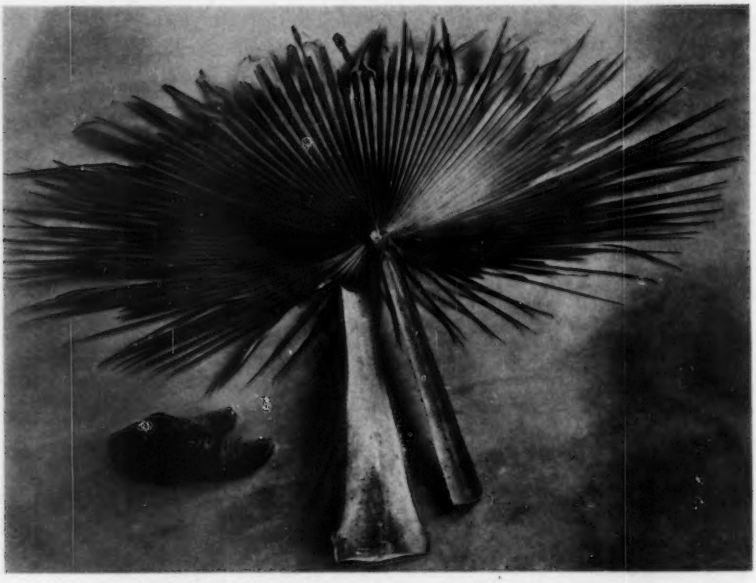

FIG. 17. FAN LEAF OF MEDIUM SIZE, freshly collected; CORYPHA, planted in Cuba.

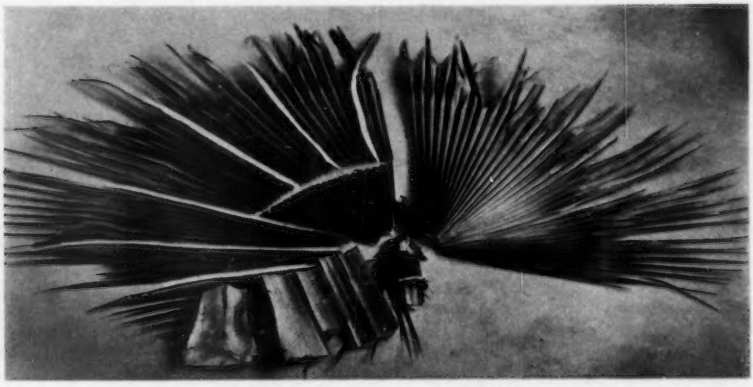

FIG. 18. PREPARATIONS FOR THE HERBARIUM. Leaf shown in Fig. 17, with right half to be discarded, and the other half cut into pieces that are to be folded and pressed; petiole in pieces, that are to be kept.

A supply of fresh flowers is also preserved in liquid, containers for which are regularly carried into the field in a camera case or in a physician's vial case. For common small flowers the author uses strong wide-mouth 4-dram vials that measure about 18 by 85 mm. In the luggage he likes to have 4-ounce screw-top jars in screw-top mailing-cases for the larger pieces and for special work.

Similarly, the entire fruiting-cluster may be pressed when small, and large clusters are cut into parts; or in great trusses like the attaleas and scheeleas the parts may be packed in boxes. In certain palms, the little grape-like berries preserve well when pressed in the usual way, but commonly the fruits are dried and handled in bags, being placed eventually in the herbarium boxes at home. Pulpy fruits may be preserved also in liquid, in addition to the usual dry material.

The spathes are often unhandy to manage. Sometimes they are several feet long, frequently heavy and woody (Fig. 6). Thin membranous sheaths and sheathlets may be folded and pressed; large stiff ones are often cut into lengths and handled in the same way as petioles.

Often it is requisite that different plants of the same species be collected, to record natural variation. On Barro Colorado Island, for example, there were noticeable differences between colonies of Geonomas of the same species, as one finds them elsewhere between stands of Rubus, of Fragaria, and of Vitis. There were marked variations in fruits of one species of Bactris, and this feature has been noted frequently in other palms. One sometimes wonders whether species founded mostly on small differences in fruits may not in fact be natural variations between individuals of one palm.

It is equally essential to the eventual understanding of the palms that experience be accumulated in the form of good herbarium material from all the regions where palms grow, as we now accumulate suites of other plants representing areas, localities, exposures, climates. We must fill the gaps in palm collections, with many specimens of every species to represent range, geographical distribution, and variation. Perhaps some of the species we now think to be local may prove to be forms of species of much wider distribution in nature.

This result has been experienced with members of a Cocos group once supposed to be quite distinct, but which now, with the accumulation of much material, seem to be better assembled into what Beccari calls a synspecies; this polymorphous group becomes a monotypic genus, *Arecastrum Romanzoffianum*, and *Cocos plumosa*, *C. Datil*, *C. botryophorum*, *C. Arechavaletana*, *C. australis*, and *C. flexuosa* of horticulturists, become parts of it. Apparently something of this kind is in prospect in Pritchardia. Many species were distinguished by Beccari and Rock in their striking monograph of the genus, which is specially developed in Hawaii (A Monographic Study of the Genus Pritchardia, Bishop Museum, Honolulu, vii,

1-77, 1921). Harold St. John has recently published brief Notes on Pritchardia (Bishop Museum, ix, 1932) in which he writes "I challenge the validity of the taxonomic characters that have been used to divide the genus *Pritchardia* into such a large number of species." These characters rest largely on shape and size of fruits, and on the pubescence of the flower-cluster. A single tree visited by Dr. St. John in the Koolau Mountains in December 1929 and in September 1930 yielded fruits and clusters at the two dates with as different characters as those employed in separating species. He also states that cultivated trees raised from type collections of published species "are now so much modified by their growth under artificial conditions that it is impossible to make them fit into the described species."

One does not really understand a species in any plants until one is able to associate other material with the type specimen.

There are two additional adjuncts to a palm herbarium in these days, the photograph and the note-book. In the writer's experience, the first undertaking after trees are located, and examined as to availability, is to photograph the bush or tree together with a close-up of the trunk if it is peculiar. A leaf is also photographed, usually detached from the tree where it can be placed for best effect. Flower-cluster and fruit-cluster are similarly photographed. The pictures in this paper indicate the practice.

All photographs are taken with a stand camera on 5 x 7 inch (12.7 x 17.8 cm.) film, and flowers and small fruits natural size often on 4 x 5 (10.2 x 12.7), all carefully focussed and exposed for detail. Many large parts, as bases of petioles more than a foot across, may be represented only in photographs, although nothing can take the place of the object itself. Camera should be adjusted to correct perspective so that the palm boles will remain parallel to their tops; this requires a camera modified for the purpose. A photograph of a palm tree is one thing; of a landscape with a palm tree in it is quite another thing.

Films are tray-developed by hand regularly as the work proceeds. The author carries with him the few simple outfits and supplies for such work; the developing is at night in whatever room may be available if water is to be obtained.

The collecting and the photographing go hand in hand as a regular routine, one not getting ahead of the other; then the records are kept intact with no danger of slips or loss of memory; and if any film is unsatisfactory, others may be exposed before the collector leaves the locality. Once home, prints are made, and films with prints are filed together in envelopes or pockets directly with the specimens in the herbarium. The author has not been able to meet all these requirements with films in rolls or with small cameras in the hope of subsequently enlarging the pictures.

Palms are collected by number. To each piece a small numbered merchandise tag is affixed. The pieces may become scattered in many bundles

in the course of a long journey but they all bring themselves together in the end. The note-book keeps the record. Developed films are immediately given the same number in ink, so that there can be no mistake. Large objects like petioles that do not readily take tags are numbered in ink; and all bags and boxes are similarly numbered. From first to last, from collecting through photography and note-taking, one tree or plant bears one number, even though there may be twenty elements in the record. Moreover, all specimens in the final folders in the herbarium are similarly numbered on looped merchandise tags, even though the folder itself is also fully labelled. These many pieces of many palms may be scattered all over the shop when one is studying them, but they come home at night each in its own place.

All this is not pen-knife collecting. If the collector is properly equipped he will have a good binocular field-glass with direct vision for the purpose of locating flowers and fruits in high crowns, heavy pruning-shears and stout knives, machete, saw, strong cutting hooks that may be fastened on long poles, small steel tape for measuring, sometimes ladder and ropes. With big palms several men may be required. This makes collecting seem real and worth the effort. One does not go by airplane, or with any fancy, conventional or theoretical equipment. The heavier palms are the big game of the plant world.

The reader is not to infer that a collector is able to assemble all this material in every big palm that is attacked; and in any case the work is not as alarming as it sounds. If one is emotionally ready, the program works out naturally and pleasantly. The sense of conquest is in it. Not often is a collector able to obtain complete material in one assault. The plant may be at the moment sterile, or only in fruit or flower; as in other collecting, one is often compelled to be satisfied with only partial results but this lack has the advantage of stimulating the collector to go back in another season or year to complete the work. When the cargo is all at home and housed, it does not seem to be bulky or to occupy more room than should be allotted a palm tree. One pigeon-hole, together with a box or two, ordinarily accommodates even the large species. In Fig. 19 is shown the opened case containing the native palms of Panama discussed in Fascicle II.

The space that the material occupies, however, depends greatly on the way in which it is prepared and handled. Sufficient pressure should be applied to make the specimens flat. Heavy weights are best, but in travel one must ordinarily depend on straps. The specimens should be kept flat in the pile, and so transported. It is a frequent careless practice to pile and tie herbarium specimens so that bundles are thick in the middle and thin at the sides, making a semi-cylinder: this causes poor specimens in any case, and with heavy stiff palm material the curvature of the pieces may never be wholly corrected. See that all bundles are kept flat and even, with plenty

of stiff cardboard between, and that the job is workman-like and presentable. This reduces requirements in the cabinets aside from providing better material with which to work.

As in the collecting of other plants so in palms the writer prefers full-size driers 12 x 18 inches, to allow the making of ample specimens, to protect them, and to insure good pressure on the ends and sides. Palm pieces are commonly placed in folders of heavy strong absorbent paper in preference to newspapers; folds rather than single sheets protect the specimens and prevent loss of loose parts and labels, and also allow the pack to be "worked" from top or bottom without confusion, and the finished specimens carry much better in transportation.

FIG. 19. CERTAIN PALMS OF PANAMA.

While the collecting of palms may be the first objective in an excursion in fertile palm country, that effort need not consume all one's energy or obscure the interest in other vegetation. Always in

these journeys do the writer and his partner collect everything else in sight, wild and cultivated.

Not all that the collector needs to know about the palm can be shown in the herbarium material and in the photographs. The remainder of it is in the note-book. Sizes and colors should be entered there, measurements, peculiarities of the base and of the attachment of the petiole, armature and other covering of the trunk, and incidental but important matters that strike one at the moment. The writer has not been able to use printed "field labels", which are often recommended.

The reader asks whether this abundance of material is necessary. Not always for mere identification of recognized species; but if one has in mind a fairly faithful account of a palm as an organism in nature the problem requires evidences and proofs. Never has the writer felt, when he gets home, that he has really covered the need or that he has too much material for the study of any species; always is there one more piece that should have been taken. In floras with which we are familiar, long experience of many persons has accumulated in the manuals good descriptions as well as ample technical diagnoses, so that we have gradually developed knowledge of the many kinds of plants of the region, but such may not be the case in the palms.

Even with all the gardens, herbaria and books, the records are static in the absence of persons who know. Long experience with the plants in field and cabinet is requisite to full results; judgment on genera and species in palms develops slowly through years of attention to them.

Students of palms are ever confronted with lack of proper evidences. Seldom does one find even approximate representation of a species in herbarium collections; and the parts obtained by one collector may not be comparable with those taken by another. Result is that descriptions of palms commonly lack the strong and pictorial quality so necessary to an understanding of plants. As evidence of the embarrassment an author feels, quotation may be made from the late Odoardo Beccari of Italy, master student of palms, in his account of the Sabals (Webbia, ii, 12): "La presente rassegna del genera Sabal non è che un tentativo di monografia, poche essendo le specie di questo genere completamente note. In generale negli Erbari, di una data specie di Sabal, ora mancano le fronde, ora i fiori, ora i frutti, e delle fronde in generale non si hanno per lo più che dei frammenti. Con tali materiali si caspisce senza difficoltà come sia impossibile uno studio monografico di un genere, i di cui componenti si distinguono fra di loro per caratteri pochissimo salienti." Similarly, Burret speaks of the inadequacy of material in his treatment of Orbignya and related genera (Notizblatt, x, 494): "Durchgreifende, gute Gruppierungen und Schlüssel werden im allgemeinen auch durch das unzureichende Material erschwert, vor allem fehlt fast immer ein vollständiger Ast des weiblichen Kolbens."

As the author stated at the outset, he is not giving advice on how to collect palms; he is only describing his present practice. This practice is for the purpose of assembling a special palm collection to serve for critical study. He began with ordinary herbarium specimens and grew away from them. It is not to be assumed that the general collector, not an enthusiast in palms, can take such pains in the making of palm specimens or acquire so much material, but perhaps the foregoing remarks will suggest some of the requirements even in ordinary collecting. It is much to be desired that all collectors take specimens of palms, along with other plants, when in regions where they grow.

THE CLASSIFICATION OF PALMS

To Linnæus in 1753 nine palms were known: *Chamærops humilis* of Europe, *Borassus flabellifer* of India, *Corypha umbraculifera* in India and its variety *thebaica* (now Hyphæne), *Cocos nucifera* in India, *Phœnix dactylifera* in India, *Areca Cathecu* in India, *Elate sylvestris* (Phœnix) in India, *Caryota urens* also in India. In the third edition of Species Plantarum, 1764, the number remains the same. The palms are placed in the group Palmæ, not in the classes of the formal sexual system of Linnæus. The name Palmæ was continued by Jussieu in his arrangement of natural families in 1789, and it has been employed by most authors to the present time. This name is only the plural form of the Latin *palma*, as rosæ is of *rosa*. In the sense of a Latin plural the word Palmæ ("Palms") is employed on the exterior title of the present fascicle, not as a caption for a botanical family. In 1846, in his Vegetable Kingdom, Lindley employed the word Palmaceæ for the palm family, and this title is preferred by the present writer, as carrying a significance different from "Palms" and conforming to most of the family names. In present practice, simple plurals are more likely to be chosen for subfamilies, tribes and sections. The International Rules state that Palmæ, along with Gramineæ and a few others, constitute historic exceptions to the usual form-ending *-aceæ*, but they impose no obligations. The American Code does not mention these cases. Other names have been proposed, as Phœnicaceæ and Arecaceæ, but they carry no systematic advantage.

The Bentham and Hooker organization of the palms, 1883, recognizes 132 genera of palms. The Drude treatment in Die Pflanzenfamilien admits 128 genera. Any subsequent Genera Palmarum will greatly increase these numbers. In the Bentham and Hooker arrangement, the eastern hemisphere palms are 78 and the western hemisphere 51 genera, assuming that Polynesia is accounted eastern; and 3 genera are native in both hemispheres. These three are Cocos, Elæis, Raphia. The recent treatment by Beccari separates *Cocos nucifera* as monotype of the genus Cocos, ascribed to the eastern hemisphere; the other species formerly assigned to that genus represent western hemisphere genera. The present writer intends to restrict

Elæis to the eastern hemisphere. This leaves only Raphia with species native in both hemispheres, disregarding Beccari's inclusion of the Cuban Colpothrinax in the Polynesian Pritchardia.

The treatment by Bentham and Hooker disposes the palms of the world in six tribes, distinguished by leaf characters (as whether pinnate or flabellate), position of flower-clusters, flowers imperfect or hermaphrodite, nature of fruits and seeds. The tribes are Arèceæ, Phœniceæ, Corypheæ, Lepidocaryæ, Borasseæ, Cocoineæ. The Areca tribe is much the most extensive, comprising 79 genera of pinnate-leaved palms in both hemispheres; with this tribe are placed genera of dubious affinity, Manicaria, Leopoldinia, Nipa, Phytelephas. Only Phœnix comprises Phœniceæ, native in tropical and subtropical Asia and Africa. The Corypha tribe includes 21 genera of fan-palms (flabellate or palmate), nearly half in the eastern hemisphere. Livistona of the eastern and Sabal of the western hemisphere are well-known representatives. The Lepidocaryum tribe includes 14 genera of loricate-fruited palms, both pinnate and palmate, mostly of the eastern hemisphere; here belongs the great genus Calamus, the rattan palms of Asia, Africa and Australia. The Borassus tribe has 4 Old World genera of heavy palmate palms. The Cocos tribe, pinnate palms with nut-like fruits bearing three pores or "eyes," is mostly western, with such important genera as Bactris, Desmoncus, Acrocomia, Attalea, Scheelea, Maximiliana, Orbignya. Cocos itself, as we have noted, is now defined as a monotypic genus, and 7 segregated genera are western.

The Drudean treatment in Die Pflanzenfamilien is six years more recent than the Hookerian in Bentham and Hooker, being the latest symposium of the family. It follows the extensive study by Drude of the palms of Brazil published in Flora Brasiliensis. This survey recognizes two main divisions in the palm family,—126 genera with six-parted perianth and single fruits, and Phytelephas-Nipa with rudimentary floral envelopes and aggregate capitate fruit-clusters, the latter being the Phytelephantinæ of northwestern South America, Panama and of Philippines-Malasia. The remaining four subfamilies are: Coryphinæ, with the Phœnix and Sabal tribes; Borassinæ of a single tribe comprising 6 Old World genera; Lepidocaryinæ, comprising the loricate Mauritia, Metroxylon, Raphia and Calamus tribes and subtribes; Ceroxylinæ, including all the remainder, namely the Areca, Caryota, Geonoma, Iriartea, Morenia, Cocos, Elæis, Attalea, Bactris tribes and subtribes. The various tribes and subtribes are separated primarily on the characters of spadix, spathe, flower and fruit.

These various groupings, as well as diagnoses of genera, are naturally subject to considerable modification as critical studies of the palms progress.